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PROCESS FOR PRODUCING LEVEL DYEINGS ON POLYAMIDE FIBERS

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This invention relates to a method of dyeing natural and synthetic polyamide fibers (e.g., wool, silk, nylons, etc.) having variable dye affinities so as to provide level dyeings which also have satisfactory fastness properties. The invention is particularly useful in connection with the dyeing of textured nylons, "deep dye" nylons and especially combinations of such fibers with regular polyamide fibers where a very high differential of dye affinity exists between the fibers forming the combination.

Another aspect of the invention is concerned with dyeing of nylons in combination with cellulosic materials capable of being dyed with acid dyes (e.g., carpeting of nylon or wool with a jute backing). In such cases, the dyeing process of the present invention will also serve to dye the cellulosic fibers to a suitable union with the polyamide fibers and thereby eliminate the necessity of employing selected direct dyes, polyamide reserving agents and the like in order to dye the cellulosic component.

One of the characteristics of synthetic polyamide fibers, even with fibers produced from a common reaction mass, is their lack of uniformity as to many physical properties. These property variations are chiefly caused by differences in molecular orientation and the degree of polymerization. Density is one of the most common properties which will vary over a relatively wide range, and density variations in turn, appear to be related in some way to the varying affinity that the polyamide fibers exhibit for dyes.

Heretofore, the variable dyeing affinity of the polyamide fibers has been of such a magnitude that it has precluded obtaining level (uniformity as to shade and depth) dyeings with dyes of the type which also would give a satisfactory degree of fastness from the standpoint of light, water, washing, sublimation and crocking. In other words, with certain dyes—namely, the so-called neutral acid dyes—a high degree of fastness could be obtained but the dyeing would not be level. Conversely, with other dyes (e.g., the dispersed type dyes) level dyeings could be obtained but only by sacrificing fastness properties.

By the present invention, a process has been provided which will permit the use of water soluble neutral dyeing dye-stuffs, such as the acid dyes, neutral acid dyes and the neutral premetallized acid dyes for the dyeing of polyamide fibers so as to produce level dyeings having the known desirable fastness properties of this class of dyes.

The objects of this invention are accomplished by the process of dyeing polyamide fibers having variable dye affinities so as to produce a level dyeing having high fastness properties which method involves passing the fibers through an aqueous dye bath which contains a water soluble neutral dyeing dye for such fibers and an organic swelling agent for the fibers in which the dye is soluble. During the dye application operation, the dye bath is maintained at temperatures below about 90° F. After the fibers have been removed from the dye bath they are steamed under conditions comparable to those provided by a three minute steam treatment at atmospheric pressure.

Suitable polyamide fibers for use in accordance with the present invention includes both natural and synthetic

materials such as wool, silk, nylons and the like. The fibers can be in any form which is convenient for handling such as staple form, continuous filaments, yarns, threads, or in any of the many forms known to the textile industry and especially as warp, woven, tufted or knitted fabrics, lace in the piece and similar finished or semi-finished yarn products.

Suitable dyes for use in accordance with the present invention are the so-called acid dyes for polyamide fibers which are soluble in water. Such dyes include the acid dyes, neutral acid dyes and the neutral premetallized acid dyes. Typical acid dyes for use in the invention include the monoazo, diazo and anthraquinone dyes which contain water solubilizing groups such as Acid Yellow 40 (C.I. 18950), Acid Red 114 (C.I. 23635), Acid Blue 27 (C.I. 61530) and dyes of the type disclosed in the copending application owned by applicants' assignee Serial No. 75,112, filed December 12, 1960, are also useful for providing red and scarlet shades. Such dyes are capable of dyeing nylons under either acid or substantially neutral conditions depending on the dye affinity of the particular fiber involved. Typical neutral premetallized acid dyes include dyes having a 2:1 dye-metal complex such as Acid Yellow 114, Acid Orange 60, Acid Red 182 and Acid Brown 28 (C.I. designations).

Any suitable means of applying the dye liquor to the fibers can be employed. For the treatment of fabric forms, spraying or immersion operation can be employed, however, a continuous pad bath is generally considered to be most satisfactory. In passing the fabric through the padder, the temperature of the bath should be maintained below about 90° and preferably at room temperature. The material should be passed through the bath at a rate such that little or no substantial dyeing occurs. If the temperature is much in excess of 90° F., there will be some dyeing of the material coming out of the pad bath and, in accordance with the present invention, dyeing at this stage of the operation is to be avoided. The object of this operation merely being to apply a surface coating of the dye to the fibrous material and to remove the material from the pad bath before any substantial degree of dying occurs.

After the dye liquor has been applied to the material, the excess liquor can be removed by any conventional means such as squeezing, suction, extraction and the like or by a combination of such means e.g., squeezing and suction. In this way, a uniform distribution of the dye on the surface of the material is obtained.

By employing a cold dye solution, the dyeing affinity is thereby minimized and the desired uniform distribution of the dyes on the surface can be effected before actual dyeing commences.

The dye bath made in accordance with the present invention should be substantially neutral (a pH of about 6.5 to 8.5 and preferably at a pH of 7 to 8) and should also contain an organic swelling agent for the fibers in which the dye is soluble. A suitable group of swelling agents for use in accordance with the invention are the lower alcohols such as isopropanol, methanol, ethanol and other readily water soluble alcohols. Because of its higher boiling point and lower toxicity, it is preferred to employ isopropyl alcohol. Further, it is preferred to employ dye baths which contain about 20% of alcohol (methanol, ethanol or isopropanol). However, level dyeings can be obtained with as little as 10% of the alcohol. An upper limit of about 30% is prescribed but only because of the economics involved a solvent recovery system is economically desirable if the alcohol concentration is in the ranges above the 30% figure.

The organic swelling agents are used to insure substantially complete solubility of the dyestuffs in the cold dye bath and to facilitate the wetting of the fibers. The swell-

ing agents also enable the dye to thoroughly penetrate the fiber during the subsequent dyeing operation.

The dye baths may also include thickeners such as carboxy methyl cellulose, alginates, etc. which are soluble in the dye liquor; and where such thickeners are used, they will increase the dye solution pick-up of the fibers undergoing treatment.

After the application of the dye from the cold dye bath, the material is steamed for a minimum of three minutes at atmospheric pressure or for an inversely proportionate length of time at elevated steaming pressures. During the steaming operation, dyeing takes place. The steaming operation appears to cause even greater swelling and permit deep uniform penetration of the dye into the fiber. On the other hand, dry heat at this stage, does not enable the dye to penetrate deeply or uniformly and will give a marked differential in shade and depth of dyeing.

After steaming, the material is dried and followed by rinsing or washing, if necessary. In most cases, subsequent rinsings or washings are not essential as the dyes are deeply penetrated into the fibers themselves.

The following examples will serve to illustrate how the invention may be carried out:

Example #1

Textured polyamide fabric was entered in a dye bath (pH 7.5) at room temperature (70° F.) made up as follows with neutral dyeing acid colors:

	Percent
Acid Yellow 40 (C.I. 18950)	0.25
Acid Blue 27 (C.I. 61530)	0.16
Acid Red 114 (C.I. 23635)	0.01
Carboxy methyl cellulose	0.3
Isopropyl alcohol	20
Water to 100%.	

The fabric was padded at a rate of about 5 yards per minute and was removed from the dye bath before any substantial degree of dyeing occurred and was extracted by passing it through squeeze rolls adjusted to give 40% solution retention (based on fabric weight). The treated fabric was steamed for three minutes at atmospheric pressure and dried.

The dyeing shows excellent coverage of the polyamide fibers, far superior to machine dyeing, while the fastness to light, washing sublimation and crocking are excellent.

By using 10% alcohol in the dye solution, no appreciable differences were noted.

Example #2

Carpeting composed of tufted textured polyamide fibers and having a jute backing was padded through a solution of neutral acid colors at room temperature. The solution had a pH of 7.5 and was made up as follows:

	Percent
Acid Blue 27 (C.I. 61530)	0.9
Acid Yellow 40 (C.I. 18950)	0.1
Acid Red 114 (C.I. 23635)	0.2
Carboxy methyl cellulose	0.3
Isopropyl alcohol	20.0
Water to 100%.	

The treated carpeting was run through squeeze rolls with minimum pressure, then over a suction plate (it can be run either face or back down) adjusted to give 62% solution retention based on the weight of the fabric, and then steamed for three minutes at atmospheric pressure and dried.

This dyeing provided excellent coverage on the polyamide fibers and the jute was dyed to an acceptable match for depth and shade. The light fastness, water stability, crocking and sublimation fastness were excellent.

Example #3

A fabric composed of the so-called "Deep Dye" textured polyamide fibers (Chemstrand Corporation) in combination with regular textured polyamide fibers was dyed by immersing the fibers in a neutral solution of:

	Percent
Acid Yellow 40 (C.I. 18950)	0.25
Acid Blue 27 (C.I. 61530)	0.18
Acid Red 114 (C.I. 23635)	0.01
Carboxy methyl cellulose	0.3
Isopropyl alcohol	20.0
Water to 100%.	

The fibers are immersed in this solution at room temperature, extracted before any significant dyeing had occurred, and then steamed at atmospheric pressure for three minutes and dried.

Both types of fibers were dyed to an acceptable union and with excellent fastness to light, washing, sublimation and crocking.

Example #4

Example 1 was repeated except that no thickener (the carboxy methyl cellulose) was used in the pad bath. The results were identical except that the depth of shade was substantially reduced.

In all of the foregoing examples, the fabric was entered into and removed from the dye bath before any substantial degree of dyeing had occurred.

We claim:

1. A process producing level dyeings on polyamide fibers which comprises passing the fibers through an aqueous bath having a pH of about 6.5 to 8.5 containing a water soluble neutral dyeing dye for such fibers and an organic swelling agent for the fibers in which the dye is soluble, maintaining the bath at a temperature below about 90° F., removing the fibers from the dye bath before any substantial degree of dyeing occurs and thereafter subjecting the treated fibers to steaming under conditions comparable to those obtained by about a 3-minute steam treatment at atmospheric pressure.

2. A process for dyeing polyamide fibers which comprises passing the fibers through an aqueous bath having a pH of about 6.5 to 8.5 containing a water soluble dye selected from the group consisting of acid dyes, neutral acid dyes and neutral premetallized acid dyes, and an organic swelling agent for the fibers in which the dye is soluble, maintaining the bath at a temperature below about 90° F., removing the fibers from the dye bath before any substantial degree of dyeing occurs and thereafter subjecting the treated fibers to steaming under conditions at least comparable to those obtained by a 3-minute treatment at atmospheric pressure.

3. A process according to claim 2 wherein the swelling agent is a water soluble alcohol.

4. A process according to claim 3 wherein the alcohol constitutes from about 10–30% of the dye bath and contains from one to three carbons.

5. A process producing level dyeing on polyamide fibers having variable dyeing affinity which comprises passing the fibers through an aqueous bath having a pH of about 6.5 to 8.5 and containing a water soluble neutral dyeing dyestuff for such fibers and an organic swelling agent for the fibers in which the dye is soluble, maintaining the bath at a temperature below about 90° F., removing the fibers from the dye bath before any substantial degree of dyeing occurs, and thereafter subjecting the treated fibers to steaming under conditions comparable to those obtained by about a 3-minute steam treatment at atmospheric pressure.

6. The process according to claim 5 wherein the polyamide fibers comprise an admixture of deep dye polyamide fibers and regular polyamide fibers.

7. The process according to claim 5 wherein the polyamide fibers are textured nylon.

8. The process of level dyeing textured polyamide fibers in combination with jute fibers which comprises treating the fibers according to claim 5.

9. The process of level dyeing wool in combination with

jute fibers which comprises treating the fibers according to claim 5.

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